



Disinfection Byproducts



DWA WG
April 18, 2017
Mia Gonzales



DBP Formation



Four primary factors:

- Disinfectant (type & amount)
- Natural organic matter
- Water age
- Temperature

Stage 2 DBP Sampling



- Number of sites based on water source and population.
- DBP2 sites should represent areas with highest DBP levels or locations that are most likely to have elevated levels.



Stage 2 DBP MCLs

Name	MCL
Trihalomethanes	0.080 mg/L
Haloacetic Acids	0.060 mg/L

Based on an average of results at each sample site (running annual average)!

Stage 2 DBP Compliance



- Compliance based on locational running annual average (LRAA), §290.115(b)(1)
- Generally use 4 consecutive quarters of monitoring but can calculate compliance using less than 4 quarters
- Add the four most recent quarters of data **for one sample site** and divide by four

$$Q1 + Q2 + Q3 + Q4 = \text{Sum}/4 = \text{LRAA}$$

Drinking Water Watch



<http://dww2.tceq.texas.gov/DWW/>



DWW DBP2 Sample Locations



Water System Sampling Points						
Facility ID	Facility Name	Fac Type Code	Smpl Pt ID Type Code Status	Location	Designations	
					Type	Begin/End Date
DS01	DISTRIBUTION SYSTEM	DS	ASB-01 - DS - A	2814 AVE F		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-01 - DS - A	2814 AVE F		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-02 - DS - A	3021 MOCKINGBIRD		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-03 - DS - A	3808 AVE N		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-04 - DS - A	909 ELIZABETH		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-05 - DS - A	2733 US HWY 59 S		
DS01	DISTRIBUTION SYSTEM	DS	DBP1-05X - DS - A	GENERATED BY BATCH		
DS01	DISTRIBUTION SYSTEM	DS	DBP2-01 - DS - A	2733 US HWY 59 S		
DS01	DISTRIBUTION SYSTEM	DS	DBP2-02 - DS - A	3021 MOCKINGBIRD		
DS01	DISTRIBUTION SYSTEM	DS	DBP2-03 - DS - I	3808 AVE N		
DS01	DISTRIBUTION SYSTEM	DS	DBP2-04 - DS - I	2814 AVE F		
DS01	DISTRIBUTION SYSTEM	DS	DSTCRRP - DS - A	REPEAT TCR SAMPLE		
DS01	DISTRIBUTION SYSTEM	DS	DSTCRRT - DS - A	ROUTINE TCR SAMPLE		
DS01	DISTRIBUTION SYSTEM	DS	DSTCRSP - DS - A	SPECIAL TCR SAMPLE		
DS01	DISTRIBUTION SYSTEM	DS	DSTWQP - DS - A	LCR SAMPLE POINT		
DS01	DISTRIBUTION SYSTEM	DS	LCR001 - DS - A	1920 PINE		
DS01	DISTRIBUTION SYSTEM	DS	LCR002 - DS - A	1208 BERNARD		
DS01	DISTRIBUTION SYSTEM	DS	LCR003 - DS - A	1925 TREMONT		
DS01	DISTRIBUTION SYSTEM	DS	LCR004 - DS - A	2712 MONROE		

DWW DBP2 Results



Result List by Analyte

Analyte Code	Analyte Name	Facility	Sample Point	Sample Collection Date	TCEQ Sample ID	Laboratory Sample ID	Concentration	Method	Detection Limit	Current Maximum Contaminant Level Allowed (MCL)
2950	TTHM	DS01	DBP2-01	05/05/2015	1546680	AC90482	Less than Detection Limit	524.2	4 UG/L	80 UG/L
2950	TTHM	DS01	DBP2-02	05/05/2015	1546681	AC90483	Less than Detection Limit	524.2	4 UG/L	80 UG/L
2950	TTHM	DS01	DBP2-01	05/20/2014	1440028	AC54717	Less than Detection Limit	551.1	4 UG/L	80 UG/L
2950	TTHM	DS01	DBP2-02	05/20/2014	1440029	AC54714	1.1 UG/L	551.1		80 UG/L
2950	TTHM	DS01	DBP1-01	05/09/2013	1354430	AC19055	1.2 UG/L	524.2		80 UG/L
2950	TTHM	DS01	DBP1-02	05/09/2013	1354431	AC19039	2.8 UG/L	524.2		80 UG/L
2950	TTHM	DS01	DBP1-03	05/09/2013	1354432	AC19041	2.2 UG/L	524.2		80 UG/L
2950	TTHM	DS01	DBP1-04	05/09/2013	1354433	AC19050	Less than Detection Limit	524.2	4 UG/L	80 UG/L
2950	TTHM	DS01	DBP1-01	06/15/2012	1243012	AB92978	1.1 UG/L	502.2		80 UG/L
2950	TTHM	DS01	DBP1-02	06/15/2012	1243013	AB92973	Less than Detection Limit	502.2	4 UG/L	80 UG/L
2950	TTHM	DS01	DBP1-03	06/15/2012	1243014	AB92966	2.1 UG/L	524.2		80 UG/L

Operational Evaluation Level Reporting



The OEL Report is an evaluation of the water system meant to help you identify the cause of high DBP levels

$$Q2 + Q3 + Q4 + Q4 = \text{Sum}/4 = \text{OEL}$$

- Required if TTHM exceeds 0.080 mg/L or HAA5 exceeds 0.060 mg/L

How is the report organized?

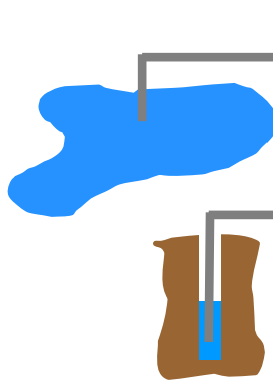


Monitoring Results Summary

$$\frac{(Q2+Q3+(Q4 \times 2))}{4}$$

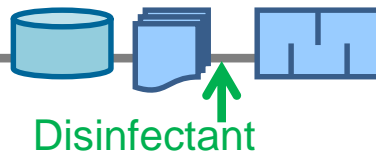
Where's the exceedance?

Source Water Evaluation



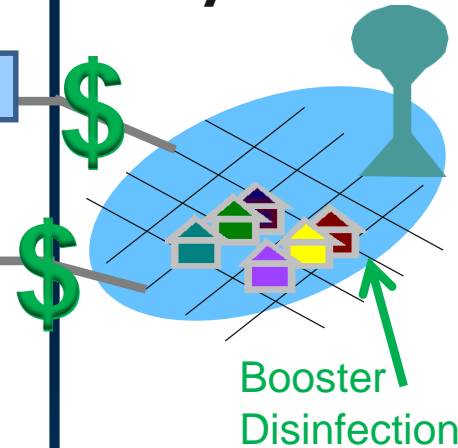
Temperature
DBP
Precursors

Disinfection and Treatment



Time
Temperature
Disinfectant
Precursor
Removal

Distribution System



Time
Disinfectant
Temperature

Future Actions



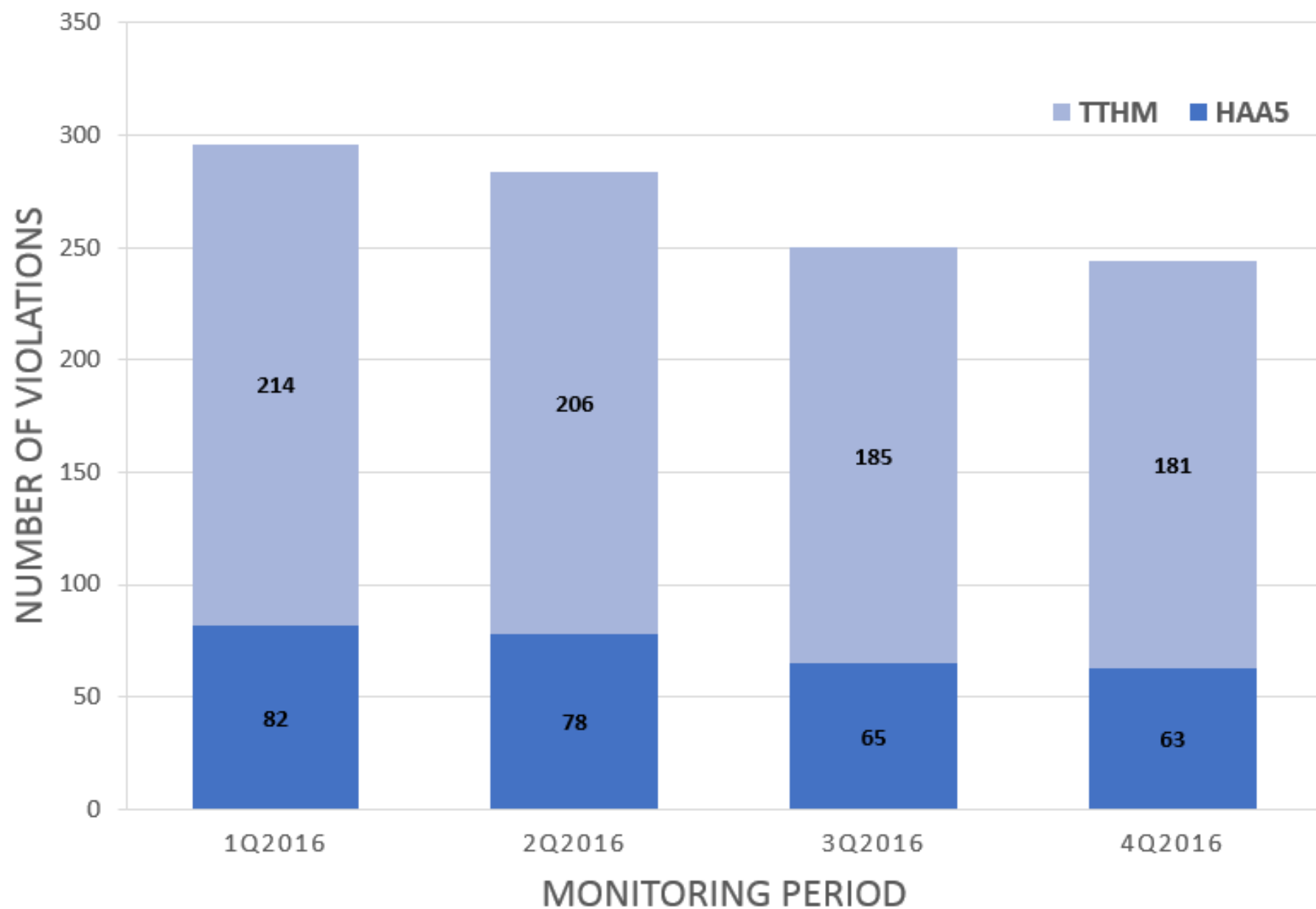
What are you going to do?

DBP Statistics



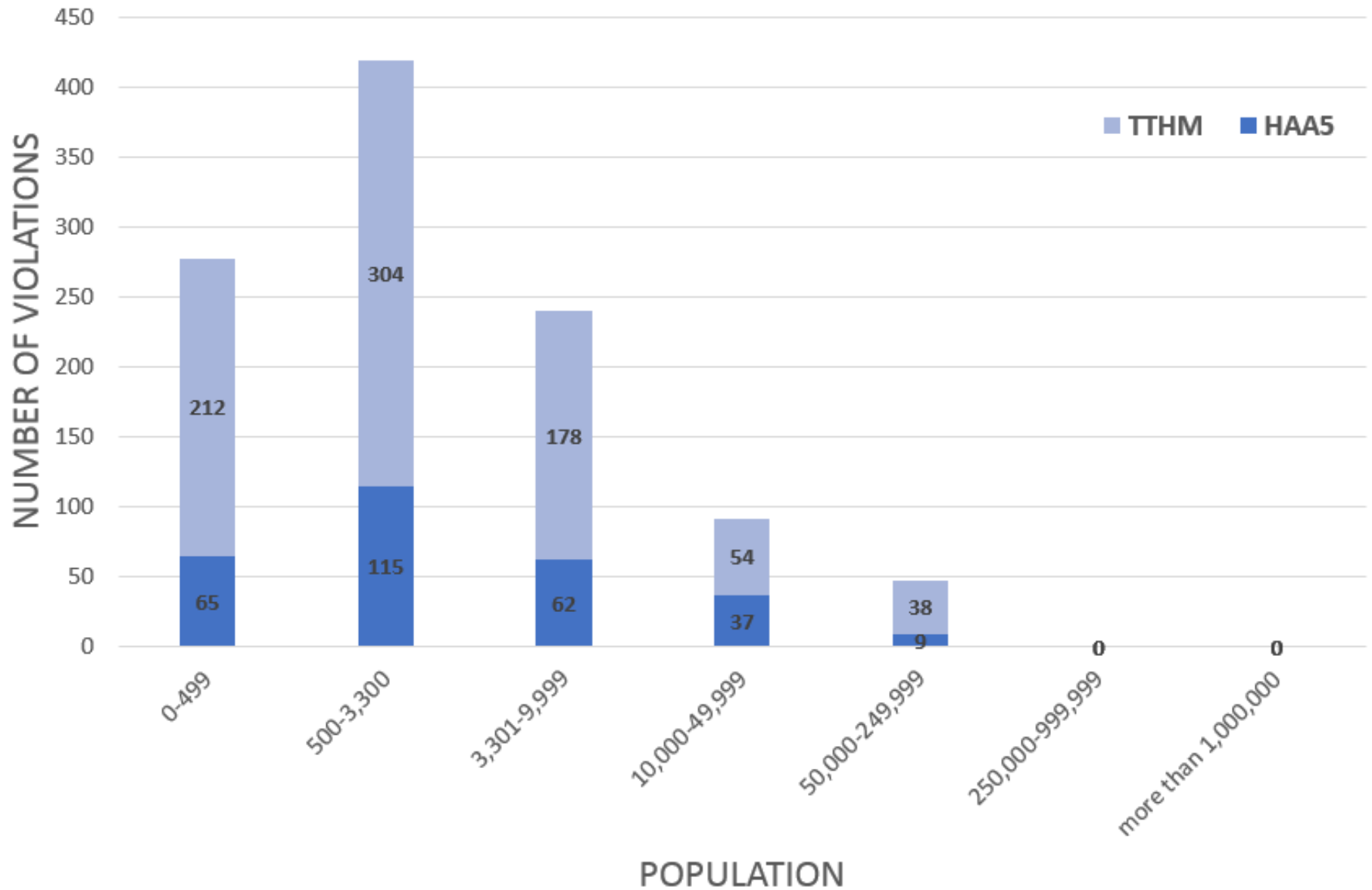
- 4.4% of PWS in 2016 had one or more DBP violations
 - 235 community
 - 9 non-transient non-community
- 1,074 violations total
 - 409 have been returned to compliance
 - 665 are still active

2016 DBP VIOLATIONS BY MONITORING PERIOD



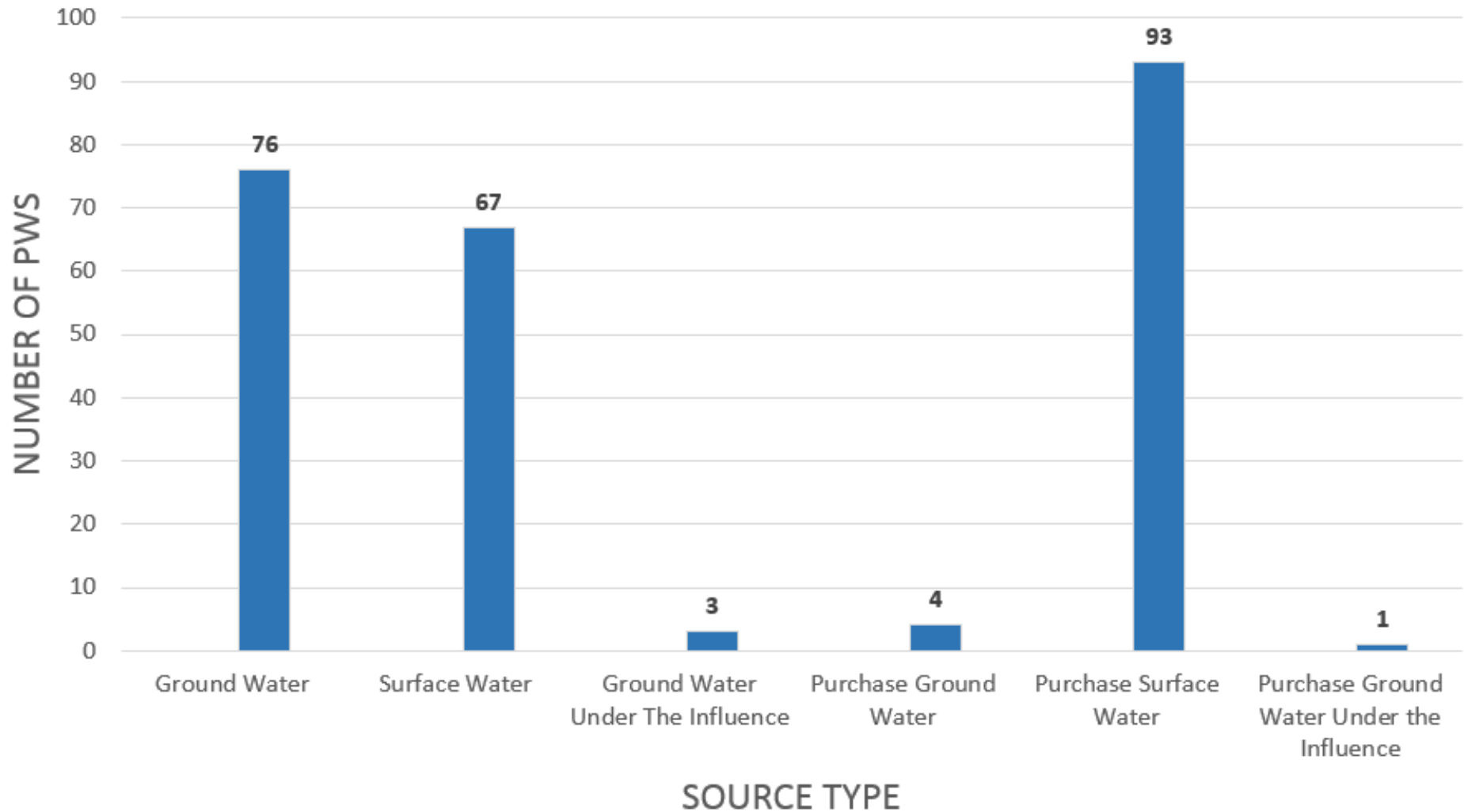


2016 DBP VIOLATIONS BY POPULATION

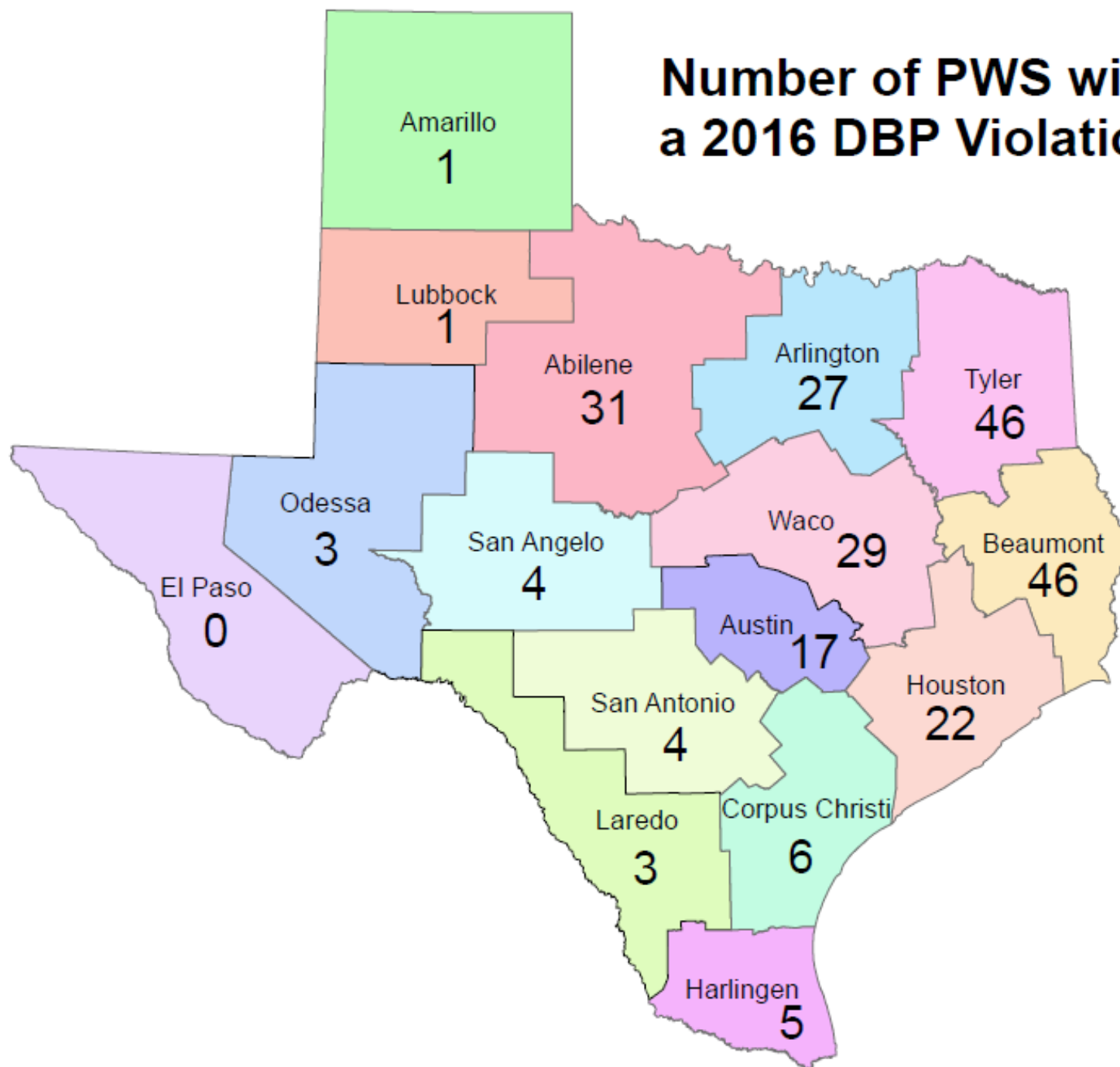




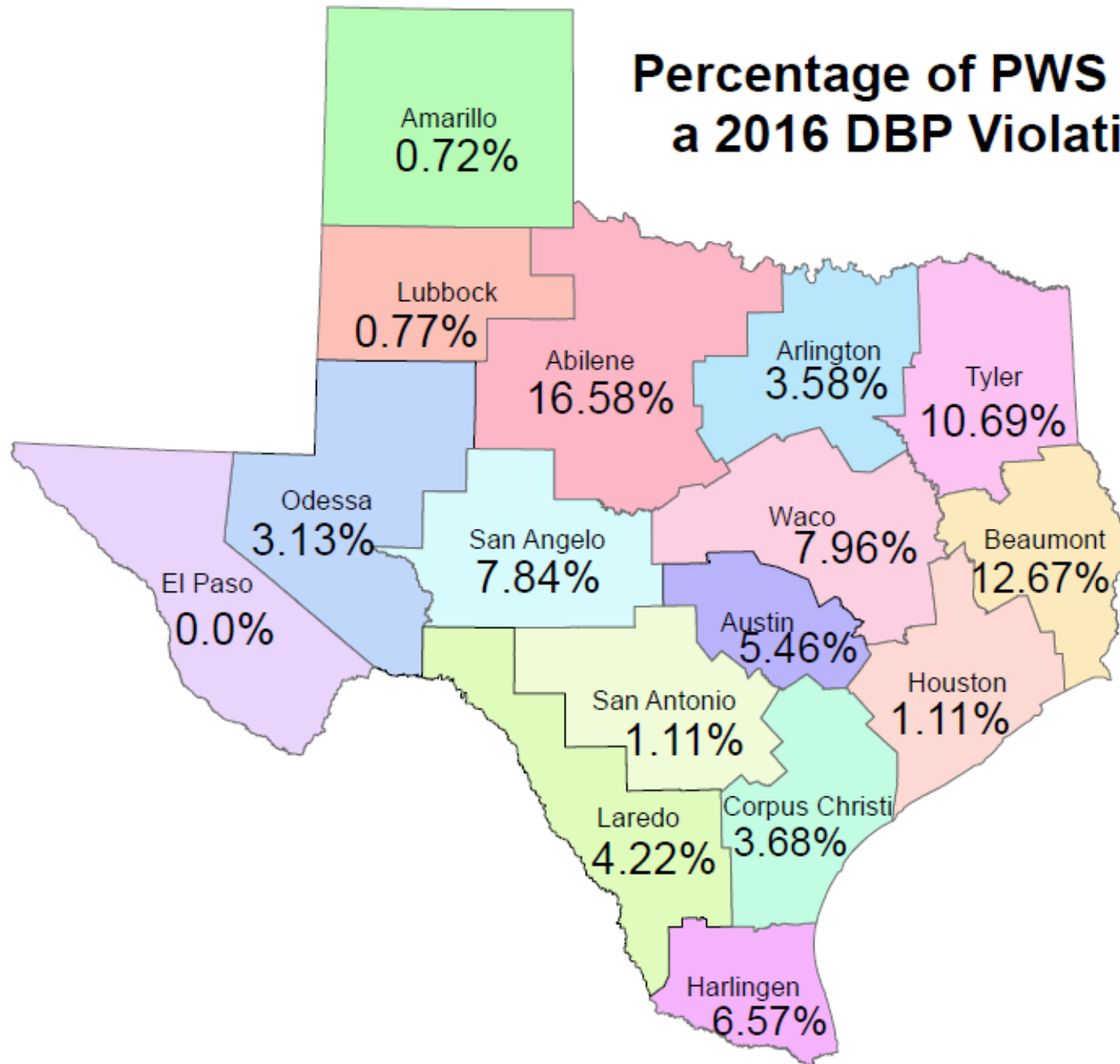
2016 DBP VIOLATIONS BY SOURCE TYPE



Number of PWS with a 2016 DBP Violation



Percentage of PWS with a 2016 DBP Violation



DBP Questions



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Disinfection Byproducts



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Disinfection Byproducts



- This presentation excludes chlorite and bromate
- Total Trihalomethanes (TTHM)
- Haloacetic Acid (HAA₅)
- Chlorine + total organic carbon (TOC) = disinfection byproducts

TTHM



- Chloroform (forms slowly)
- Bromoform (brominated species form very quickly)
- bromodichloromethane
- dibromochloromethane

TTHM



- Brominated species contribute more to TTHM values when source waters have higher concentrations of bromide (e.g. source water exposed to marine or estuary intrusion and certain geological formations)
- Chloroform is usually more dominant when source water bromide levels are low
- pH, temperature and reaction time are big drivers in formation

Texas Drinking Water Watch



- You can view results on this publically available website: <http://dww2.tceq.texas.gov/DWW/>
- Chemical results, sort by name

Texas Drinking Water Watch



[Texas Commission on Environmental Quality](#)

[Office of Water](#)

[Public Drinking Water Section](#)

[County Map of TX](#)

[Water System Search](#)

[Office of Compliance and Enforcement](#)

[Water System Detail](#)

Water System Facilities	Violations Enforcement Actions	TCR Sample Results	TTHM HAA5 Summaries
Source Water Assessment Results			
Sample Points	Assistance Actions	Recent Positive TCR Results	PBCU Summaries
Sample Schedules / FANLs / Plans	Compliance Schedules	Other Chemical Results	Chlorine Summaries
Site Visits Milestones	TOC/Alkalinity Results	Chemical Results: Sort by: Name Code	Turbidity Summaries
Operators All POC	LRAA (TTHM/HAA5)	Recent Non-TCR Sample Results	TCR Sample Summaries

[Glossary](#)

Texas Drinking Water Watch



<u>2942</u>	BROMOFORM
<u>2214</u>	BROMOMETHANE
<u>2076</u>	BUTACHLOR
<u>2294</u>	BUTYLBENZYL PHTHALATE
<u>1015</u>	CADMIUM
<u>1016</u>	CALCIUM
<u>2021</u>	CARBARYL
<u>2046</u>	CARBOFURAN
<u>1902</u>	CARBON DISULFIDE
<u>2982</u>	CARBON TETRACHLORIDE
<u>2920</u>	CARBON, TOTAL
<u>2205</u>	CHLORAMBEN
<u>2959</u>	CHLORDANE
<u>1017</u>	CHLORIDE
<u>2989</u>	CHLOROBENZENE
<u>2216</u>	CHLOROETHANE
<u>2941</u>	CHLOROFORM

TTHM



- Brominated species can severely limit the application and effectiveness of free chlorine at a surface water treatment plant because of the limited exposure time needed for formation
- Chloroform can allow more flexibility when using free chlorine because of its nature to form more slowly

IMPORTANT!



- Surface water treatment plants (SWTP) are required to meet a certain disinfection protocol for the inactivation and/or removal of viruses, giardia and cryptosporidium. This protocol and subsequent parameters are outlined in the TCEQ approved Concentration Time (CT) Study
- Flow through treatment units, detention time, pH, water temperature and disinfection type and concentration are major factors used to assess the effectiveness or success of pathogen removal

IMPORTANT!



- Chloramines are less aggressive with precursor organics responsible for forming TTHM and HAA₅s but are approximately 20 times less effective as a disinfectant. Therefore, feeding chloramines at the head of a surface water treatment plant may not result in regulatory compliance with the inactivation and/or removal of viruses, giardia and cryptosporidium
- Must continue to meet turbidity requirements

Strategies for lowering TTHM's



- Review previous sample results and determine dominant species (i.e. chloroform or brominated)
- Review disinfectant type(s) and application point(s) at SWTP and in distribution (e.g. how much contact time with chlorine before ammonia fed)
- Collect samples for TOC and TTHM's at the different treatment units (for example after sedimentation recycle stream)

Strategies for lowering TTHM's



- Limit or eliminate the use of free chlorine prior to sedimentation/clarification
- Remove as much of the organic precursors as possible before introducing chlorine compounds
- Use of alternate disinfectants such as chlorine dioxide or ozone (requires TCEQ approval and additional process monitoring/control protocols)

Strategies for lowering TTHM's



- Enhanced coagulation
 - Aluminum sulfate (alum) – Drive pH down to 5.5 – 6.5
 - This pH range allows for greater removal of organic matter through the sedimentation process
- Do not use free chlorine in distribution
- Ensure flushing is conducted at least once every 30 days or more frequently to reduce water age (emphasis on uni-directional flushing UDF). This is especially true for systems with high chloroform results. Increased water age can lead to higher TTHM values

Strategies for lowering TTHM's



- Evaluate the installation of mixing/aeration equipment in ground and elevated storage tanks if the system is experiencing poor mixing and elevated chloroform levels
- Deep cycle storage tank(s) periodically
- Purchased water systems should not boost with free chlorine if the incoming water is chloraminated

Strategies for lowering TTHM's



- Maintain proper pH for chloramines at the treatment plant and in the distribution
- Use good process monitoring and control techniques to determine your dosing strategies
- Having and implementing a good Nitrification Action Plan (NAP)

Wholesale Providers



- Be a good water wholesaler! Don't sell water to another public water system just below the maximum contaminant level for disinfection byproducts
- Effective communication, coordination and cooperation is essential

Questions?



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